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Asbestos-Containing Materials in School Buildings: Bulk Sample Analysis Quality Assurance Program

Midwest Research Inst.
Kansas City, MO

Prepared for

Environmental Protection Agency
Washington, DC

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Washington DC 20460

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Toxic Substances

EPA

Asbestos-Containing Materials in School Buildings:

Bulk Sample Analysis Quality Assurance Program

Round Two

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16. ABSTRACT

The second round of the Environmental Protection Agency (EPA) voluntary quality assurance (QA) program for commercial laboratories claiming capability in the polarized light microscope analysis of bulk samples for asbestos was conducted in August and September, 1980. Seventy-six laboratories each received bulk samples of two asbestiform minerals and two nonasbestos materials: amosite, crocidolite, cellulose, and wollastonite. A performance rating based on correct classification of positive (asbestos) and negative (nonasbestos) samples was scored for and reported to participating laboratories. Among the inaccurate results reported were 3 false negatives (crocidolite) and 32 false positives (3 cellulose, 29 wollastonite). QA program results are made available to the laboratories, the EPA, and the public. Continuation of the QA program with future sample sets is anticipated.

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March 1981

ASBESTOS-CONTAINING MATERIALS IN SCHOOL BUILDINGS: BULK SAMPLE ANALYSIS QUALITY ASSURANCE PROGRAM

ROUND TWO

By

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Disclaimer

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Abstract

This report presents the results of commercial laboratories participating in the second round of the bulk sample analysis quality assurance program sponsored by the U.S. Environmental Protection Agency Asbestos-in-Schools Program. Seventy-six laboratories which accept bulk samples for determination of asbestos content by polarized light microscopy participated in the second round.

Laboratories received bulk samples of two asbestiform minerals (amosite, crocidolite) and two nonasbestiform materials (cellulose, wollastonite). Three aspects of the analytical results are considered: classification of a sample as either asbestos (positive) or nonasbestos (negative); identification of the specific type of asbestos or nonasbestos material present; and quantitation of the relative amount of the major constituent present. A performance rating was made for each laboratory, based only on the ability to correctly classify samples. Reductions of the all-correct (4/4) score were made only for the reporting of false positives and false negatives. The distribution of performance ratings is: 4/4, 46 laboratories; 3/4, 25 laboratories; 2/4, 5 laboratories. The majority of classification errors were false positives on the wollastonite sample.

Continuation of the program with future sample sets is anticipated. Any commercial or noncommercial laboratories with capability for polarized light microscope analysis of bulk samples may participate. Results of commercial laboratories are made available to the EPA and to the public.

This report is submitted in fulfillment of Midwest Research Institute Subcontract No. 47-4900-8 by Research Triangle Institute. The work was sponsored by the U.S. Environmental Protection Agency under Contract No. 68-01-5915 to MRI. The report covers a period from August 1, 1980, to October 31, 1980, and work was completed March 31, 1981.

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ASBESTOS-CONTAINING MATERIALS IN SCHOOL BUILDINGS: BULK SAMPLE ANALYSIS QUALITY ASSURANCE PROGRAM

1. INTRODUCTION

The Environmental Protection Agency (EPA) Asbestos-in-Schools Program has designated polarized light microscopy (PLM) as the method of choice for detecting asbestos fiber in bulk insulation samples.* In January 1980, a voluntary quality assurance (QA) program was initiated for laboratories claiming capability in PLM analysis of bulk samples. This QA program is part of the EPA Asbestos-in-Schools Program.

Round 1 of the program was conducted in January and February 1980 and Round 2 was conducted in August and September 1980. Any commercial or noncommercial laboratory with PLM analytical capabilities could participate. The following is a report on commercial laboratories that participated in Round 2.

The QA program is not designed for laboratory accreditation and does not seek to certify or endorse participating laboratories. Laboratories are notified that a rating will be made of their performance. Participating commercial laboratories and their performance ratings are included in a source listing that is made available to EPA regional asbestos coordinators, to state asbestos contacts, and to the public via a toll-free number established to provide technical information. Further information on the QA program, participating laboratories, sampling and analysis of asbestos-containing materials, and the EPA Asbestos-in-Schools Program is available by contacting the author at 1-800-334-8571.

2. PROCEDURES

2.1 Reporting Form and Instructions

Instructions and a reporting form developed for laboratory use in communicating analytical results are included as Appendix A. The form satisfies various information needs, including identity of asbestos and

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*Asbestos-Containing Materials in School Buildings: A Guidance Document, EPA/OTS #C00090, March 1979.

Asbestos-Containing Materials in School Buildings: Guidance for Asbestos Analytical Programs, EPA 560/13-80-017A, December 1980.

nonasbestos fibers, analytical method(s) used, quantitation procedures used, and quality control measures employed.

2.2 Selection and Distribution of Samples

Four bulk samples were sent to each laboratory. Two were asbestos fiber, amosite and crocidolite, and two were nonasbestos fibrous materials, cellulose and wollastonite, commonly found in insulations. The samples were doublebagged, coded, and packaged with a reporting form and instructions for analysis. Sample packages were mailed on August 1, 1980, to ninety commercial laboratories requesting participation.

2.3 Reference Reports

A reference analytical report was obtained from the Bureau of Mines, U.S. Department of the Interior, Avondale, Maryland, and is included as Appendix B. Reference report data were the basis for comparison in determining a laboratory's performance rating and were included in reports to the laboratories.

2.4 Reports to Laboratories

Reports were issued to individual laboratories on October 31, 1980. Reports included the results of reference analyses, data reported by the individual laboratory, and summary data on quantitative estimates.

Estimates provided by the laboratories of the relative amounts of sample constituents were averaged for each sample lot. Means and standard deviations were included in reports to the laboratories. Values reported were not used in rating laboratory performance. The distributions of quantitative estimates were recorded on histograms and included in individual reports to allow laboratories to place themselves within the distribution.

2.5 Performance Rating

Laboratory performance was assessed on the basis of correct classification of "positive" and "negative" samples. Reductions of the all-correct (4/4) score were made only for classification errors involving the reporting of either false positives (nonasbestos sample reported as containing asbestos) or false negatives (no asbestos reported in an asbestos-containing sample).

Many laboratories were successful in classifying a sample as positive or negative but made an error in identifying the specific type of asbestos or nonasbestos material present. These errors will be referred to as identification errors. The criterion used for performance scoring, although not accounting for identification errors, recognizes the basic concern of the public--whether or not asbestos fibers are present in a submitted sample. Performance ratings were included in laboratory reports and are listed in Appendix C.

3. RESULTS

Seventy-six of the ninety commercial laboratories supplied with samples reported results on or before September 15, 1980. These laboratories are designated as participants in Round 2 and are listed in Appendix C.

A total of 304 (76 × 4) samples were analyzed. Of the 304 samples, 253 were correctly classified and identified. Reporting laboratories were in error on 51 samples, primarily wollastonite. Incorrect analyses included 3 false negatives, 32 false positives, and 16 identification errors (Table 1).

All laboratories correctly classified the amosite sample as asbestos. Crocidolite was correctly classified as asbestos by 73 laboratories. Three laboratories identified the crocidolite sample as mineral wool (nonasbestos). Crocidolite is an anisotropic fiber and can be distinguished from (isotropic) mineral wool by observation with crossed polars. Pleochroism and sign of elongation are also optical properties diagnostic for crocidolite.

Cellulose was correctly classified as nonasbestos by 73 laboratories. The cellulose sample was falsely reported as chrysotile by two laboratories and as amosite by one laboratory. Attention to morphology, extinction characteristics, and refractive index (or dispersion staining colors) should distinguish cellulose from asbestos fiber.

The most prevalent error occurred in the classification of the nonasbestos material wollastonite. Forty-seven laboratories correctly classified the sample. Of the twenty-nine laboratories which classified the sample as asbestos (false positive), twenty-six identified it as an amphibole and three identified it as chrysotile. Wollastonite can be distinguished from chrysotile by determination of refractive indices. In Cargille liquid 1.550, wollastonite does not show dispersion staining colors (all λ_o < 400 nm), and thus should not be confused with chrysotile. Wollastonite shows good

TABLE 1. QUALITATIVE RESULTS

Lot	Number of samples analyzed	Number of correct[a] analyses	Number of classification errors[b]		Number of identification errors[c]
			False negatives	False positives	
A. Amosite	76	69	0		7
B. Crocidolite	76	72	3		1
C. Cellulose	76	70		3	3
D. Wollastonite	76	42	-	29	5
TOTAL	304	253	3	32	16

[a]Sample was correctly classified and identified.

[b]Samples may be classified as asbestos-containing (positive) or as non-asbestos (negative). Classification errors are false positives or false negatives.

[c]Identification errors are incorrect designations of the specific type of asbestos or nonasbestos material present. Identification and classification errors are mutually exclusive categories; i.e., incorrect classifications are not counted as identification errors.

dispersion staining colors in Cargille liquid 1.620. The amphiboles incorrectly reported included tremolite, actinolite, and anthophyllite. These minerals have refractive index ranges totally including the range of wollastonite, and therefore cannot be distinguished from wollastonite solely on the basis of refractive index. In addition to information gained by dispersion staining in Cargille liquids 1.605 and 1.620, wollastonite may be distinguished from the above amphiboles by noting the sign of elongation of sample fibers. Because of random orientation of particles, a mounted sample of milled wollastonite will contain some fibers with positive signs of elongation and some fibers with negative signs of elongation. Mounted samples of chrysotile and the asbestiform amphiboles reported contain only fibers with positive signs of elongation.

The majority of laboratories participating in Round 2 received a performance rating of 4/4. Recall that reductions of the all-correct score (4/4) are made only for classification errors. A breakdown of identification errors within performance ratings is shown in Table 2. Most laboratories scoring 3/4 incorrectly classified the wollastonite sample as asbestos and did not make any identification errors. Summing classification and identification errors, it can be seen that three laboratories were in error on 3 of 4 samples and one laboratory was incorrect on all 4 samples.

The distribution of quantitative results is presented in Table 3. This information is supplied to laboratories to enable them to compare their quantitative results with other participating laboratories. Quantitative results are not presently used in determining the laboratory performance rating.

4. PLANS

The third round of the continuing QA program is currently planned for spring 1981 and will also involve the distribution of samples and reporting of PLM analysis results. Any commercial or noncommercial laboratories with PLM capabilities may participate. The list of commercial laboratories will be updated with performance ratings and participating laboratories following each round. Future rounds are anticipated and will include samples of asbestiform and nonasbestiform minerals as well as samples of insulation materials removed from schools and private buildings.

TABLE 2. DISTRIBUTION OF QUALITATIVE ERRORS

Performance rating	Number of classification errors	Number of identification errors		Number of laboratories
4/4	0	0		38
		1		8
			Subtotal	46
3/4	1	0		22
		1		2
		2		1
			Subtotal	25
2/4	2	0		2
		1		2
		2		1
			Subtotal	5
			Total	76

TABLE 3. DISTRIBUTION OF QUANTITATIVE RESULTS

Percentage reported for major component[a]	Number (cumulative %) of laboratories reporting[b]			
	Lot A	Lot B	Lot C	Lot D
	Ref. value 99	Ref. Value 95	Ref. value 99	Ref. value 95
96 - 100	23 (31%)	15 (21%)	36 (51%)	25 (63%)
86 - 95	29 (70%)	19 (48%)	23 (83%)	12 (93%)
76 - 85	13 (88%)	10 (62%)	10 (97%)	
66 - 75	4 (93%)	11 (77%)	2 (100%)	2 (99%)
56 - 65	2 (96%)	12 (94%)		
46 - 55	2 (99%)	1 (96%)		
36 - 45		1 (97%)		1 (100%)
26 - 35	1 (100%)	1 (99%)		
16 - 25		1 (100%)		
6 - 15				
0 - 5				
Percentage not reported	2	2	2	7
Total	76	73	73	47

[a]Asbestos (lots A, B); nonasbestos (lots C, D).

[b]Classification errors were omitted.

APPENDIX A
INSTRUCTIONS AND REPORTING FORM

ASBESTOS BULK SAMPLE ANALYSIS PROGRAM

Research Triangle Institute 800-334-8571, ext. 6741

INSTRUCTIONS:

1. Verify that this kit contains four bulk material samples.
2. If this kit is incomplete or contains broken sample packages:

   PHONE: 800-334-8571
   ASK FOR: Gene Brantly, ext. 6741
   Asbestos Bulk Sample Analysis Program

3. Perform a complete analysis of each sample by polarized light microscopy, with or without dispersion staining. X-ray diffraction should be used only as a confirmatory technique.
4. Record the requested information on a copy of the Results Reporting Form. Final results of the analyses of all samples should be reported on one form.
5. Fill in all blocks for each analysis performed, using zeros where necessary. In categories offering numbered choices, write the correct number in the appropriate block, followed by a percent value or comment. All reported values should be expressed as percentages of the total material in each sample. Reporting forms with incomplete information will not be evaluated.
6. Include the laboratory identification number and sample identification numbers on all Results Reporting Forms. The space labelled "Sample Code Assigned by Laboratory" should be used for internal quality control programs involving split samples.

   Example Sample Labels: 2750-01-372
   2750-01-149
   2750-01-967
   2750-01-730

   Laboratory ID#2750

Sample ID#	01-372	01-149	01-967	01-730

7. Complete the reverse side of the Results Reporting Form. Information on quantitation and quality control procedures supplied in previous rounds need not be repeated if still applicable.
8. Retain all samples for reference following receipt of the round results and statistical summary.
9. Return the Results Reporting Form within 15 working days after receipt of the samples. Mail to:

   Gene Brantly
   Dreyfus Laboratories
   Research Triangle Institute
   P. O. Box 12194
   Research Triangle Park, North Carolina 27709

   Late Returns Will Not Be Evaluated

Results Reporting Form

ASBESTOS BULK SAMPLE ANALYSIS PROGRAM

RETURN REPORTING FORM WITHIN FIFTEEN WORKING DAYS AFTER RECEIVING SAMPLES. LATE RETURNS WILL NOT BE EVALUATED.

Laboratory I.D. #					
Sample I.D. #					
Sample Code Assigned by Laboratory					
Analytical Method (enter number)	1. PLM 2. PLM + dispersion staining 3. X-ray diffraction				
Gross Sample Appearance (enter number; note color)	1. Homogeneous, fibrous 2. Homogeneous, nonfibrous 3. Heterogeneous, fibrous 4. Heterogeneous, nonfibrous 5. Heterogeneous, mixed				
Sample Treatment (enter number)	1. Homogenized 2. Untreated 3. Other, *specify*				
Amount of Material Examined (mg)					
Asbestos Present (enter number and percent)	1. Amosite 2. Chrysotile 3. Crocidolite 4. Other, *specify*				
Percent Total Asbestos Present in Sample					
Other Fibrous Materials Present (enter number and percent)	1. Fiberglass 2. Mineral Wool 3. Cellulose 4. Other, *specify*				
Nonfibrous Materials Present (description and percent)					

(Continued: Please provide requested information on reverse side of this form.)

Description of Method of Quantitation

Description of Quality Control Program (e.g., #slides/sample, #splits/set)

Comments

Analyst: _____

Confirmation by: _____

Report Reviewed by: _____

Address Correction Please: _____

APPENDIX B
REFERENCE REPORT

United States Department of the Interior
BUREAU OF MINES
4900 LASALLE ROAD
AVONDALE, MARYLAND 20782

October 6, 1980

Mr. Gene Brantly
Research Triangle Institute
P.O. Box 12194
Research Triangle Park, N.C. 27709

Dear Mr. Brantly:

The samples, Lots A through D , submitted for analysis have been examined using optical microscopy for mineralogy. The results of the examination are given below.

Lot A:	Amosite	>99%
	Opaques	Trace
	Carbonates	Trace
	Mica	Trace
Lot B:	Crocidolite	>95%
	Opaques	1%
	Carbonates	1%
	Chlorite?	Trace
	Hornblende	Trace
	Organics	Trace
Lot C:	Cellulose fiber	>99%
	Nonfibrous organics	<1%
Lot D:	Wollastonite	>95%
	Carbonates	Minor
	Garnet?	Trace

In addition to the minerals listed above, each sample also contained one to three unidentified phases in trace quantities. The X-ray diffraction examination of these materials will be forwarded to you upon completion.

Sincerely yours,

Robert L Virta

Robert L. Virta
Mineralogist

APPENDIX C

PARTICIPATING LABORATORIES

INTERIM LISTING NO. 9
OF COMMERCIAL LABORATORIES WITH POLARIZED
LIGHT MICROSCOPE CAPABILITIES FOR BULK ASBESTOS IDENTIFICATION
11/1/80

The following laboratories have participated in the EPA asbestos bulk sample quality assurance program. Listed laboratories analyzed samples distributed in round one and/or round two of the program. Four bulk samples were sent to each laboratory in each round. As shown below, two samples of each round contained asbestos fiber and two were nonasbestos fibrous material commonly found in insulation. All analyses were performed by polarized light microscopy (PLM).

Round One
Positive: Chrysotile, anthophyllite
Negative: Mineral wool, fiberglass

Round Two
Positive: Amosite, crocidolite
Negative: Cellulose, wollastonite

Laboratory performance was assessed on the basis of correct identification of "positive" and "negative" samples. Reductions of the all-correct (4/4) score were made only for the reporting of false positives (nonasbestos sample reported as containing asbestos) or false negatives (no asbestos reported in an asbestos-containing sample), and not for the misidentification of individual asbestiform mineral species. The criterion, though lenient, recognizes the basic concern of the public--whether or not asbestos fibers are present in a submitted sample. Performance scores for rounds one and two are included separately on the laboratory listing. Several laboratories entered the program after the completion of round one and therefore do not have a score listed in that column.

The quality assurance program is not designed for laboratory accreditation and does not seek to certify or endorse participating laboratories. This list of program participants is provided as a source list of analytical laboratories by the EPA asbestos-in-schools program. Further information on the quality assurance program, participating laboratories, sampling and analysis of asbestos-containing materials, and the EPA asbestos-in-schools program is available by contacting Gene Brantly at 1-800-334-8571.

	Round 1	Round 2
Ms. Virginia Dugan Albuchemist, Inc. 715 San Mateo Boulevard, N.E. Albuquerque, New Mexico 87108 505/268-7367		4/4
Mr. James McVeigh American Can Company Safety & Industrial Hygiene Laboratory U.S. Highway 22 Union, New Jersey 07083 201/686-4500	4/4	3/4
Mr. M. A. Beg American Microscopy Laboratory 29 Heritage Hills Tuscaloosa, Alabama 35406	4/4	3/4
Dr. W. C. Runnels Analytical Center, Inc. P. O. Box 15635 Houston, Texas 77020 713/676-0141	4/4	2/4
Mr. Gary Gottfried Biospherics, Inc. 4928 Wyaconda Road Rockville, Maryland 20852 301/770-7700		4/4
Ms. Sherry Merritt Boeing Technology Services 9R-25 P. O. Box 3707 Seattle, Washington 98124 206/237-2722	4/4	4/4

	Round 1	Round 2
Ms. Marlene O. Frey Brandt Associates, Inc. P. O. Box 81 Martins Creek, Pennsylvania 18063 215/258-2911		2/4
Ms. Estelle Shiroma Brewer Analytical Laboratories 311 Pacific Street Honolulu, Hawaii 96810 808/533-4411	4/4	3/4
Mr. Glenn Sylvester Briggs Engineering and Testing Company 164 Washington Street Norwell, Massachusetts 02061 617/773-2780		3/4
Mr. Brig P. Tamayo C.E.D., Inc. Environmental Microscopy International 135 West Cutting Blvd. Richmond, California 94804 415/234-3761	4/4	4/4
Mr. Jerry Woodruff Cambridge Analytical Association 222 Arsenal Street Watertown, Massachusetts 02172 617/923-9376		4/4
Dr. Sam L. Casalina Casalina Associates, Inc. 47-345 Mahakea Road Kaneohe, Hawaii 96744 808/239-6514	4/4	3/4

	Round 1	Round 2
Mr. Stuart Salot Certified Testing Laboratories, Inc. 2905 East Century Boulevard South Gate, California 90280 213/564-2641	4/4	4/4
Mr. Bob Lieckfield Clayton Environmental Consultants, Inc. 25711 Southfield Road Southfield, Michigan 48075 313/424-8860	4/4	4/4
Mr. G. J. Jansen Coal Petrography, Inc. Edgemont Branch P. O. Box 10757 Golden, Colorado 80401 303/238-3435		3/4
Mr. Jerome Krause Colorado School of Mines Research Institute P. O. Box 112 Golden, Colorado 80401 303/279-2581	4/4	4/4
Ms. Fay Goldblatt Consultant 910 W. Clayton Street Waukegan, Illinois 60085 312/249-1745	4/4	4/4
Mr. Yami Yaffe Consultant 926 Riley Drive., #87 Albany, California 94706 415/526-4285		4/4

	Round 1	Round 2
Mr. David McNamara Continental Technical Services Environmental Health Division 9742 Skillman Dallas, Texas 75243 214/343-2025	4/4	4/4
Mr. Mark W. Maxwell Craig Testing Laboratories, Inc. 565 East Harding Highway Mays Landing, New Jersey 08330 609/625-1700		4/4
Dr. Joseph Bozzelli Department of Chemistry New Jersey Institute of Technology 323 High Street Newark, New Jersey 07102 201/645-5482	4/4	4/4
Dr. Martin Rutstein Department of Geological Sciences SUNY, New Paltz New Paltz, New York 12562 914/257-2166	4/4	4/4
Dr. James Kirchner Department of Geology Illinois State University Normal, Illinois 61761 309/436-8922	4/4	3/4
Mr. William E. Cutcliffe Dunn Geoscience Corporation 5 Northway Lane North Latham, New York 12110 518/783-8102		3/4

	Round 1	Round 2
Mr. Robert L. MacDonald Eastern Analytical Laboratories One "A" Street Burlington, Massachusetts 01803 617/272-5212	4/4	4/4
Ms. B. M. Tooper EMS Laboratories 12563 Crenshaw Boulevard Hawthorne, California 90250 213/973-6694	4/4	4/4
Mr. John Wehrung EMV Associates, Inc. Microanalysis Laboratory 15825 Shady Grove Road Rockville, Maryland 20850 301/948-7400	4/4	4/4
Mr. Bob O'Neill Engineers Testing Laboratory 3737 E. Broadway Road Phoenix, Arizona 85036 602/268-1381		3/4
Mr. Melvin C. Bassett Environal Research Laboratories 5 Saturn Court Baltimore, Maryland 21234 301/821-9390		2/4
Mr. Michael L. Mendelsohn Environment/One Corporation 2773 Balltown Road Schenectady, New York 12301 518/346-6161	4/4	2/4

	Round 1	Round 2
Mr. Nathan R. Frenkel Environmental Consulting & Testing Services P. O. Box 3521 Cherry Hill, New Jersey 08034 609/779-1195	3/4	3/4
Ms. Alice Farrar Environmental Health Laboratory P. O. Box 6195 Macon, Gerogia 31208 912/745-4702		4/4
Mr. Alan W. Williams Environmental Health Services, Inc. 5206 Lindbergh Blvd. W. Carollton, Ohio 45449 513/293-0025	4/4	4/4
Mr. Harold C. Krause Environmental Technology P. O. Box 127 West Hartford, Connecticut 06107 203/521-6820		4/4
Mr. Ed King Enviropact, Inc. 815 W. 18th Street Hialeah, Florida 33010 305/885-1869		3/4
Mr. Bernard Erlin Erlin, Hime Associates 811 Skokie Boulevard Northbrook, Illinois 60062 312/272-7730	4/4	4/4

	Round 1	Round 2
Mr. Jose Honnorez Geoscience Consultants, Inc. P. O. Box 341366 Coral Gables, Florida 33134 305/446-5801	4/4	4/4
Dr. Robert Hager, Jr. Hager Laboratories, Inc. 4725 Paris Street Denver, Colorado 80239 303/371-1441	4/4	4/4
Ms. Kathy Jones Health Science Associates Suite B/C 10941 Bloomfield Street Los Alamitos, California 90720 213/430-1031	4/4	4/4
Mr. Bob Haddad Herron Testing Laboratories 5405 Schaaf Road Cleveland, Ohio 44131 216/524-1450	4/4	3/4
Mr. Allan J. Gaynor IIT Research Institute 10 West 35th Street Chicago, Illinois 60616 312/567-4303	4/4	4/4
Mr. Fred Hertlein Industrial Analytical Laboratory, Inc. 1523 Kalakaua Avenue Suite 101 Honolulu, Hawaii 96826 808/947-5402	4/4	3/4

	Round 1	Round 2
Mr. James Schirripa Industrial Hygienics, Inc. 755 New York Avenue Huntington, New York 11743 516/427-0950	4/4	4/4
Mr. William A. Eddie Industrial Testing Laboratories, Inc. 2350 Seventh Blvd. St. Louis, Missouri 63104 314/771-7111	4/4	2/4
Dr. Malcolm Newman Inter-City Testing & Consulting Corporation P. O. Drawer "O" 609 Middle Neck Road Great Neck, New York 11023 516/829-8762	4/4	4/4
Mr. Joseph H. Guth Interscience Research 2614 Wyoming Avenue Norfolk, Virginia 23513 804/853-8813	4/4	3/4
Mr. James H. Carr James H. Carr and Associates 919 True Street Columbia, South Carolina 29209 803/776-7789		3/4
Dr. Jesse H. Bidanset Jesse H. Bidanset & Associates, Inc. P. O. Drawer "O" 609 Middle Neck Road Great Neck, New York 11023 516/829-8763	4/4	4/4

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Mr. Richard Hatfield Law Engineering Testing Company 3301 Winton Road Raleigh, North Carolina 27619 919/876-0416	4/4	4/4
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Mr. Kenneth Martin Martin Analytical Services 354 Salem Street Malden, Massachusetts 02148 617/321-5962		3/4
Dr. Ann Wylie Maryland Mineral Analysis Laboratory Department of Geology University of Maryland College Park, Maryland 20740 301/454-3548	4/4	4/4
Dr. Martin Rutstein Materials Analysis and Research Systems 14 Sarafian Road New Paltz, New York 12561 914/257-2166		4/4
Mr. Michael McLara McLara Laboratory Asbestos Control Division 3972 Miller Way Sacramento, California 95817 916/451-6219		4/4

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Mr. Gaylord Atkinson Midwest Research Institute 425 Volker Boulevard Kansas City, Missouri 64110 816/753-7600		4/4
Mr. Michael L. Boucher MJH Mineralogical Consultants, Inc. 13345 Foliage Avenue Apple Valley, Minnesota 55124 612/432-8836	4/4	4/4
Ms. Joan Wronski NATLSCO Environmental Science Laboratory, A-1 Long Grove, Illinois 60049 312/540-2488		3/4
Mr. R. C. Jordan Northrop Services, Inc. P. O. Box 12313 Research Triangle Park, North Carolina 27709 919/549-0611	4/4	4/4
Dr. Tom White Oklahoma City Health Department 921 NE 23rd Street Oklahoma City, Oklahoma 73105 405/427-8651		3/4

	Round 1	Round 2
Mr. Craig Caldwell PEDCo Environmental, Inc. 11499 Chester Road Cincinnati, Ohio 45246 513/782-4700	4/4	4/4
Mr. Gene Dennison Princeton Testing Laboratory P. O. Box 3108 Princeton, New Jersey 08540 609/452-9050	3/4	3/4
Dr. Robert J. Kuryvial R. J. Kuryvial & Associates Mineralogy/Microscopy Consultants 12185 W. 29th Place Lakewood, Colorado 80215 303/237-2566	4/4	3/4
Mr. Shui Fong Scientific Cleaner and Laboratory 2284 Old Middlefield Way, Unit 7 Mountain View, California 94043 415/969-4312		4/4
Mr. Gary Cude Southwestern Laboratories P. O. Box 10687 Dallas, Texas 75207 214/688-0088	4/4	3/4
Mr. Donald J. Larsen St. Paul Fire & Marine Environmental Services Analytical Laboratory 494 Metro Square Building 7th and Robert Streets St. Paul, Minnesota 55101 612/221-7043	4/4	4/4

	Round 1	Round 2
Mr. Gary C. Allen Sunbelt Associates, Inc. 6961 Mayo Road New Orleans, Louisiana 70126 504/242-5026	4/4	3/4
Mr. Thomas A. Kubic Thomas A. Kubic & Associates 8 Pine Hill Court Northport, New York 11768 516/261-2117	4/4	4/4
Mr. Frederick T. Posey Tri-State Laboratories, Inc. 54 Westchester Drive Austintown, Ohio 44515 216/793-8800	4/4	3/4
Mr. Karl Schiller Truesdail Laboratories, Inc. 4101 N. Figueroa Street Los Angeles, California 90065 213/225-1564	4/4	4/4
Mr. Ray Robinson United States Testing Company, Inc. 1415 Park Avenue Hoboken, New Jersey 07030 201/792-2400	4/4	4/4
Mr. Evan Farmer Upper Cumberland Research and Service Company 301 South Willow Avenue Cookeville, Tennessee 38501 615/528-8070		3/4

	Round 1	Round 2
Mr. James Perkins Utah Biomedical Test Laboratory 520 Wakara Way Salt Lake City, Utah 84108 801/453-8267	4/4	4/4
Dr. Ian Stewart Walter McCrone Associates, Inc. 2820 S. Michigan Avenue Chicago, Illinois 60616 312/842-7100	4/4	4/4
Mr. Thomas Stavros Wausau Insurance Companies Environmental Health Laboratory 2000 Westwood Dr. Wausau, Wisconsin 54401 715/845-5211	4/4	4/4
Mr. Meena L. Sachdev West-Paine Laboratories, Inc. 7979 GSRI Road Baton Rouge, Louisiana 70808 504/769-4900		4/4